RECOMMENDATION TO NAESB EXECUTIVE COMMITTEE

For Quadrant: **Retail Electric Quadrant**
Requesters: **Smart Grid Interoperability Panel**
Request No.: **2010 Retail Annual Plan Item 9(c)**
Request Title: **Phase Two Requirements Specification for Retail Standard DR Signals – for NIST PAP09**

1. RECOMMENDED ACTION:

X	Accept as requested
X	Accept as modified below
	Decline

EFFECT OF EC VOTE TO ACCEPT RECOMMENDED ACTION:

X	Change to Existing Practice
	Status Quo

2. TYPE OF DEVELOPMENT/MAINTENANCE

Per Request:		**Per Recommendation:**	
	Initiation		Initiation
X	Modification	X	Modification
	Interpretation		Interpretation
	Withdrawal		Withdrawal
X	Principle	X	Principle
X	Definition	X	Definition
X	Business Practice Standard	X	Business Practice Standard
	Document		Document
	Data Element		Data Element
	Code Value		Code Value
	X12 Implementation Guide		X12 Implementation Guide
	Business Process Documentation		Business Process Documentation

3. RECOMMENDATION

SUMMARY:

The business process flows, use cases and data requirements presented in this document illustrate the standard interactions between Utility Distribution Operator, Service Provider (Demand Response) and Utility Customer for the administration and deployment of demand response resources retail markets.

RECOMMENDED STANDARDS:

In response to NIST's Priority Action Plan 9, this document provides requirements specification, in the form of business process flows, use cases and data requirements in certain areas, to support the standardization of the information exchange between Utility Distribution Operator, Service Provider (Demand Response) and Utility Customer. This document shares a standard set of actors and terminologies with the companion Requirements Specification for Wholesale Standard DR Signals.

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RECOMMENDED STANDARDS:

Executive Summary

Specifications for Retail Standard Demand Response Signals

The North America Energy Standards Board (NAESB) Smart Grid Standards Subcommittee took the responsibility of consolidating and developing DR use cases that provide requirements for developing DR control and pricing signal standards, which is called for by National Institute of Standards and Technology (NIST) Priority Action Plans (PAP) 03 and 09. This document addresses the business and data requirements for standardizing control and pricing signals for Retail level Demand Response (DR) and Distributed Energy Resources (DER) as part of the Smart Grid implementation. Wholesale market DR and DER information exchanges are outside the scope of this document and are addressed in the Requirements Specification for Wholesale DR signals. The first step of use case development is the development of the Framework for Integrated DR and DER Models document, which provides an overall business context for DR and DER Models.

According to the Framework Document findings:

1. DR signals standardization must support all four market types; i.e. regions with a) no open wholesale and no retail competition, b) open wholesale market only, c) open retail competition only, d) open wholesale and open retail competition. It must also consider key differences that exist and will continue to exist in all four market types.
2. Wholesale market DR and pricing signals have different characteristics than retail market DR and pricing signals, although commonality in format is feasible.
3. Most Customers (with a few exception of Commercial and Industrial (C&I) Customers) will not interact directly with wholesale market when it comes to DR and pricing signals.
4. Retail pricing models are complex, due to the numerous tariff rate structures that exist in both regulated and un-regulated markets. Attempts to standardize DR control and pricing signals must not hinder regulatory changes or market innovations when it comes to future tariff or pricing models.
5. New business entities (Energy Service Providers (ESP), Demand Response Providers (DRP), Service Providers, and Energy Information Service Providers (ESIP)) as well as new customer energy management systems will play an increasing role in DR implementation.
6. DER may play an increasingly important role in DR, yet the development of tariff and/or pricing models that support DER's role in DR is still in its infancy.
7. The Customer's perspective and ability to react to DR control and pricing signals must be a key driver during the development of DR standards.

The following deals exclusively with the retail level demand response signals requirements. The requirements are captured in the form of UML models, where business requirements are captured in Use Case narrative format, data requirements are captured in tabular format, and information exchange flows are captured in sequence diagram format. The top level use cases for retail DR are:

1. Administrate DR Program
2. Administrate Customer for DR
3. Administrate DR Resource
4. Execute DR Event
5. Post DR Event Management

Introduction

Specifications for Retail Standard Demand Response Signals

Purpose: The purpose of the following is to capture business and data requirements for Retail Level DR signals between entities that controls and manages the DR programs and entities that provide demand response with DR resources and assets. This is to fulfill the NAESB SGTF responsibility under the NIST Smart Grid Interoperability Standards development PAP09. This requirements document will then be used by other standards development organizations identified by NIST PAP09 for further development of DR signals technical specifications for both C&I customer and residential customer markets.

Scope: The scope of the following is to provide business and data requirements for standardizing Demand Response signals at the retail (distribution) level.

Commentary on Distributed Energy Resources: In the context of this report, Distributed Energy Resources (DER) are dispatchable energy generation and storage technologies, typically up to ten MWs in size, that are interconnected to the distribution grid to provide electric capacity and/or energy to a customer or a group of customers and potentially export the excess to the grid for economical purposes. DER systems can generate electric power, as opposed to curtailable or interruptible loads that can just reduce electric loading on the grid.

DER may be subdivided into distributed generation (DG), distributed storage, and plug-in electric vehicles (PEVs):
Distributed generation (DG) technologies can be divided into a) **Renewable Generation**, e.g., small wind power systems, solar photovoltaic (PV), Fuel Cells, Bio-fuel generators and Digesters, and other generation resources using renewable fuel, and b) **Non-Renewable Generation**, e.g., micro-turbines, small combustion turbines, diesel, natural gas and dual-fueled engines, etc.

Storage resources could be divided into a) **Electric Storage,** e.g., battery systems and uninterruptible power supplies (UPS), flywheel, superconducting magnetic energy storage (SMES), etc. and b) **Thermal Storage –** These convert electric power to thermal (cooling/heating) energy for later use, e.g., Ice-based air cooling system, and high-capacity brick-based air heating system.

Plug-in electric and hybrid vehicles (PEV/PHEV) may also be considered as DER, The electric vehicles may be used to supply stored electric energy back to the grid, a.k.a. Vehicle-to-grid (V2G).

Behind-the-meter DER may be bundled with regular load and managed alongside the demand response resources – such as a residential roof-top PV solar panel. But often, DER is treated separately in part due to its control capabilities. In addition to a regular retail tariff, behind-the-meter DER may be subject to net-metering or feed-in tariff, where excess generation can be exported to the grid at an established or a dynamic price.

Similar to DR resources, DER assets need to be registered and enrolled into a DR program. Furthermore, DER assets are typically required to meet additional technical requirements and certification for grid interconnection. Depending on the size of a DER and its export capabilities, sub-metering and telemetry capabilities may be required to monitor the impact of the DER operation on the distribution grid reliability and power quality. Also, renewable resources may receive Renewable Energy Credits (RECs) and may also qualify as a must-run resource, e.g., wind power in some regions. These need to be incorporated into pricing and control signals associated with DER operation.

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Model Business Practices

REQ.17.3.1 Specifications for Retail Standard Demand Response Signals

The following describes general business processes for implementing demand response capacities at the retail market level. The following principles apply to the development and application of these business process requirements.

#	Name	Description	Rationale	Implication
1	Scalability	The architecture should allow for the management of millions of Customer premises devices	Scale-out, adding more low-cost machines, has proven to be superior to scale-up, using larger single machines, as a way to handle large loads. For example, high traffic web sites use farms of low-cost machines to serve pages to millions of simultaneous web users.	Architecture should allow the solution to scale-out as more devices are added.
2	Actionable, testable, and transferable work products	Any work (artifacts) that are created can be used by the audience for this work, e.g., utilities, vendors, regulators, etc. There needs to be clear, explicit guidance for how to use the artifacts. There is an expectation that the work products are useful at lower levels of design.	Such work products will promote market adoption and minimize the cost and risk of adoption, leverage open and best practices, and establish repeatable processes, patterns, and templates for all work products.	The use of common tools and methods will be fostered. Organizations that do not follow the use of the common tools and methods may have more difficulty implementing the artifacts.

#	Name	Description	Rationale	Implication
3	Platform Independence, Vendor Neutral	Requirements and design artifacts shall be platform independent. Implementation technology shall be chosen due to its level of acceptance at the marketplace as open standards.	There is an expectation of differentiation and innovation in the marketplace. With greater dependence on a specific platform, there may be less architectural flexibility.	To achieve both technical and semantic interoperability, certain lower level technologies will need to be chosen. For example, Web Services technology is widely used for integration, and UML is widely used for modeling.
4	Cyber Secure	Architecture must incorporate latest secure computing techniques.	The integrity of the electric grid and market depend on preventing unauthorized actors from manipulating the DR and DER system.	Architecture must comply with the latest security guidance from the NIST SGIP Architecture Committee and CyberSecurity Task Group, when it comes to Web Services security related implementation.
5	Interoperability	DR signaling standards should utilize open, interoperable industry standard control and communication technologies to integrate with both common energy management and control systems that can conduct DR activities	Interoperability across different domains of Smart Grid is key to the success of DR signaling standards as it ensures level playing field for innovative solutions for all participants of the Smart Grid.	DR signaling standards must be developed in harmonization with others relevant standards as identified by the NIST SGIP.

#	Name	Description	Rationale	Implication
6	Automatic Demand Response	The DR program (analysis, notification, event, action, monitoring, verification, settlement) should be automatic. DR signaling standards should provide secure, reliable communications with consumers for DR operations	Automation is the only way to ensure large scale and repeatable demand response implementation.	Security, reliability and testability must be ensured for DR automation.
7	Cover All Market Types	DR signaling standards should be supported and implementable in all four market types listed in this document	Standards development shall not get in the way of regulatory policy decisions.	DR signals design need to support a wide range of programs and tariff/pricing structures.

REQ.17.3.1.1 Conventions

The use case modeling technique is used for capturing business and date requirements relative to Retail Demand Response. There are two basic diagrams used in this document. The first one is the use case diagram, which shows the scope of business use cases for a given business scenario. The relationships used in the Use Case diagrams are as follows:

- Include: this indicates additional scenarios
- Extend: this indicates alternatives scenarios
- Generalization (line with triangle head): this indicates variations (sub-types) of the main use case.
- Precedes: this indicates a time sequence
- Invokes: this indicates a pre-condition or dependency

The second is the sequence diagram, which shows the information exchange flows between actors for a given use case. The message flows are shown in one way with the convention of verb and noun, verb indicating the action being taken, noun indicating the name of the information being exchanged. The return message flow is the acknowledgement of the main message flow.

REQ.17.3.1.2 ACTORS

The actors listed in the table below are specific to this Model Business Practice and are a subset of the actors and related objects defined in WEQ-000. Details on the relationships between the actors and related objects are further defined in Appendix A.

Table 1 - Actor Roles

Term	Actor ID[1]
Communication Method	5.5
Control	5.2
Designated Dispatch Entity	3.4
Designated Dispatch Entity (DDE)	3.4
End Device (ED)	4.5
Enrollment	5.3
Environmental Authority (EA)	1.3
Federal Regulator (FR)	1.1
Load Serving Entity	3.2
Load Serving Entity (LSE)	3.2
Local Authority (LA)	1.5
Market Participant (MP)	2.2

[1] The Actor ID shown in the table refers to the item number of the corresponding actor or related object in the Entity-Relationship Diagram provided in Appendix A. Definitions of the actors and related objects are included in REQ.17.2

Term	Actor ID[1]
Measurement	5.1
Metering Authority	3.6
Metering Authority (MA)	3.6
P-Node	5.6
Premise	4.3
Reliability Authority (RA)	1.2
Resource	4.1
Scheduling Entity	3.3
Scheduling Entity (SE)	3.3
Service Provider	3.1
Service Provider (SP)	3.1
State Regulator (SR)	1.4

Term	Actor ID[1]
System Operator	2.1
Transmission/Distribution Service Provider	3.5
Transmission/Distribution Service Provider (TDSP)	3.5
Utility Customer (UC)	2.4
Utility Distribution Operator (UDO)	2.3
Zone	5.4

REQ.17.3.1.3 Use Case Overview

Similar to the Wholesale Demand Response use cases, Retail Demand Response use cases generally follow five main steps, see the Figure 1[2].

1. Administrate DR Program
2. Administrate Customer for DR
3. Administrate DR Resource
4. Execute DR Event
5. Post DR Event Management

There are many programs that exist in today's retail markets with or without open competition. New programs will be defined and deployed in the future. The goal of this use case analysis is to find commonalities among these programs so that the derived DR signal messaging specification can be implemented to support a large number of DR programs.

[2] DR program administration related use cases are determined by the SGTF as out of scope for the NIST PAP09 purpose, and therefore the original content has been removed from the final recommendation and resulting Model Business Practices presented here. NAESB may start a new project to deal with the customer enrollment and DR program administration related business practices.

The focus of the Standardized DR Signals is the step 4, Execute DR Event, where the DR signals will be communicated between the DR Providers and the DR resources. All other use cases are supporting materials to ensure that DR use case requirements are documented and understood in a complete picture.

The use cases included in this document are not intended to be required or exhaustive and are provided for clarification purposes.

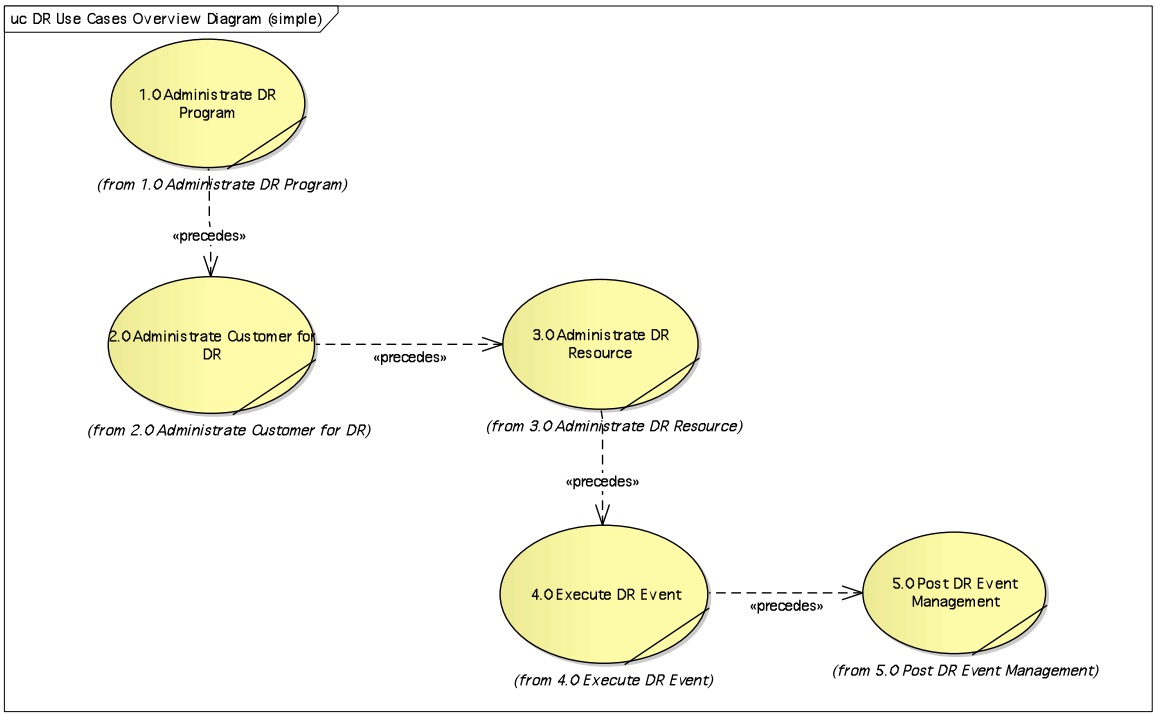


Figure 1. Retail Market DR Use Case Overview

REQ.17.3.1.4 Specific Use Cases

REQ.17.3.1.4.1 Administrate DR Program

DR program administration related use cases are determined by the SGTF as out of scope for the NIST PAP09 purpose, and therefore the original content has been removed from the final recommendation and resulting Model Business Practices presented here. NAESB may start a new project to deal with the customer enrollment and DR program administration related business practices.

REQ.17.3.1.4.2 Administrate Customer for DR

DR program customer enrollment related use cases are determined by the SGTF as out of scope for the NIST PAP09 purpose, and therefore the original content has been removed from the final recommendation and resulting Model Business Practices presented here. NAESB may start a new project to deal with the customer enrollment and DR program administration related business practices.

REQ.17.3.1.4.3 Administrate DR Resource

DR Resource is an equivalent of Resource defined in the actor list table.

As part of enrolling customers to a DR program, specific DR resources and assets that are associated with customers' accounts and premises will also need to be registered. Figure 4 shows the actors and use cases involved in administrating DR resources and/or assets into DR programs. The following use cases deal with the registration, update, and removal of DR resources and assets associated with a customer. When updating DR resources, there will also be potential use cases of DR bidding process, either for supplying or for buying power. There are also cases where Distributed Energy Resources will act as DR assets.

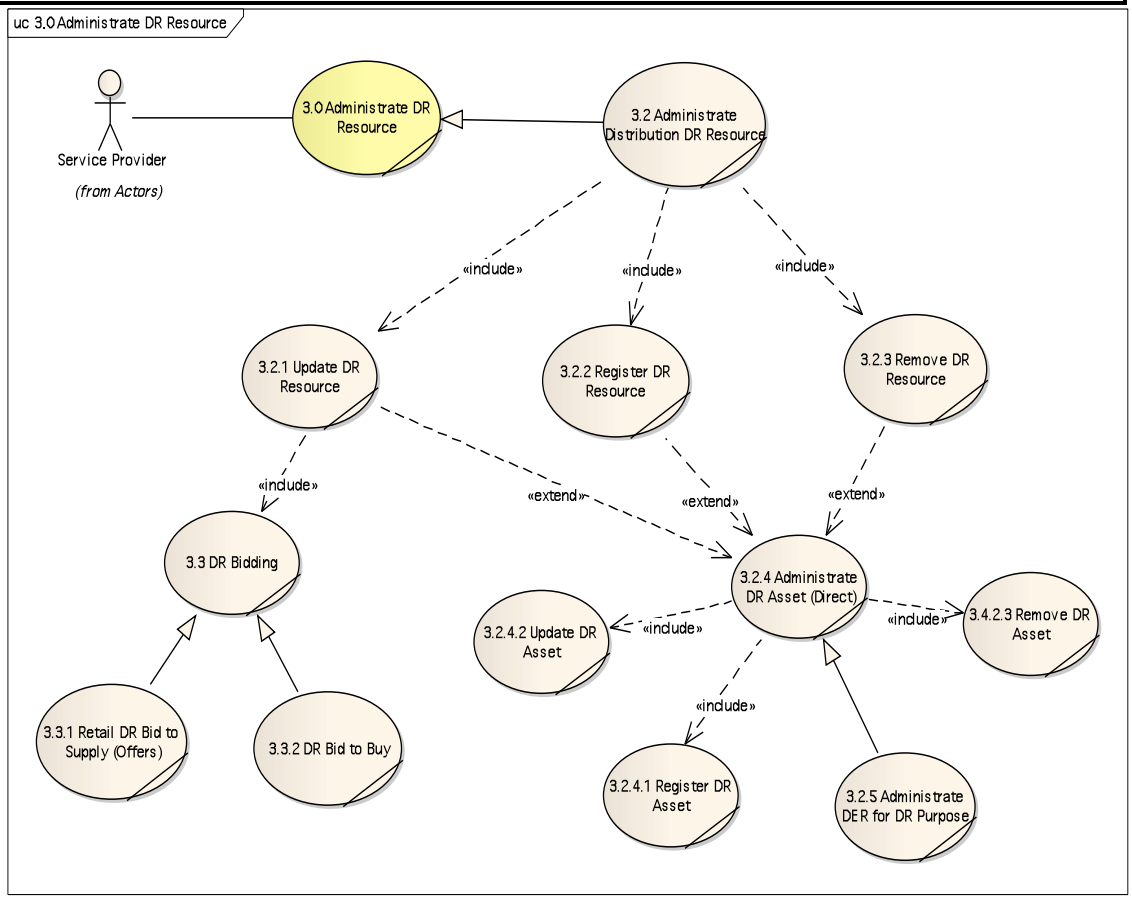


Figure 2. Administrate DR Resources and/or Assets into DR Programs

REQ.17.3.1.4.3.1 Administrate Distribution DR Resource

These activities are used to administer all of the DR Resources and Assets, including a variety of activities surrounding the registration of DR Resources and the management of information surrounding the DR Resources that a Service Provider may call upon during a DR event. Before a DR Resource may be called upon, it must be registered with the Service Provider. The administration of a DR Resource covers the following requirements:

- The need of the Service Provider to identify a DR Resource for communications purposes;
- The need of the Service Provider to establish DR Resource accounts for accounting purposes;
- The need of the Service Provider to collect information from DR Resources prior to DR events for the purposes of determining which DR Resources to call upon during a DR Event; and

- The need of the Service Provider to collect information from DR Resources prior to DR events for the purposes of determining the nature of the DR signals to send to the DR Resources.

REQ.17.3.1.4.3.2 Update DR Resource

Description

When the base capacity of a DR Resource changes from when it was last registered with the DR provider, customer needs to provide updated information to the DR provider so that such information can be factored into the consideration for DR event planning.

Data Requirements[3]

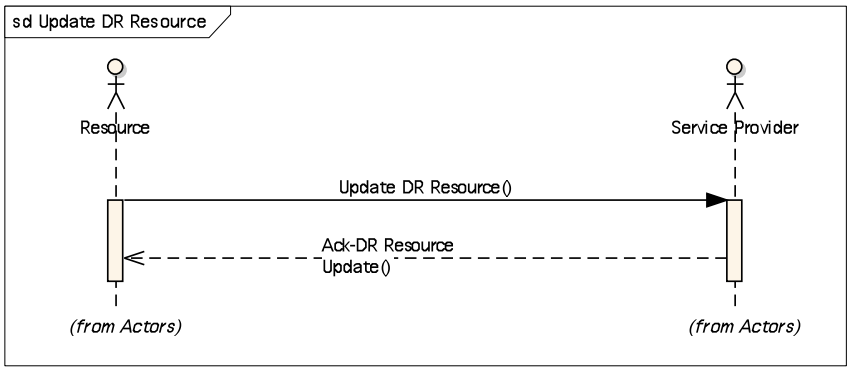
Attribute Name	Description
Resource ID	Identifier assigned to the Resource
Resource Type	Type of Resource. Examples are: load reduction (curtailable or interruptible load), generation, combination, DG, renewable, and storage.
Transmission/Distribution Service Provider Account Number	Transmission/Distribution Service Provider's (Utility) account number for the Resource.
Demand Response Provider	The entity that is responsible for delivering Demand reductions from Demand Resources and is compensated for providing such Demand Response products.
DR Resource Group ID	Grouping of Resources that can respond to the same DR Signal.
Program Identifier	The identifier of the program
Constraint Type	Type of operational, schedule or offer constraint
Constraint Interval	The timeframe over which the constraint type applies.
Constraint Value	Value of the Constraint Type and Interval
Effective Enrollment Date	Effective Start Date for the Enrollment
Location	The location of a Resource defined by one or more of the following attributes:

[3] . This Business Practice Standard and data elements included herein are not intended to replace applicable Governing Documents, and in the event of a conflict, the latter documents shall have precedence over this standard.

Attribute Name	Description
Location Attributes	
Service Location ID	Identifier assigned to the Service Location
Address1	Address line 1
Address2	Address line 2
City	City
State/Province	State or Province two-letter code
Zip/Postal Code	Zip or Postal Code
Country	Country
GPS Coordinates	Latitide and longitude
Weather Station	Weather Station code associated with the Service Location
Zone ID	Identifier assigned to the Zone in which the Service Location is located
Zone	Name of the Zone in which the Service Location is located
Electrical Node ID	Identifier assigned to the Electrical Node at which the Service Location is connected
Electrical Node Name	Name of the Electrical Node at which the Service Location is connected
Electrical Node Type	Type of Electrical Node at which the Service Location is attached
PNode	Name of the Price Node associated with the Service Location
PNode ID	Identifier assigned to the Price Node associated with the Service Location
End of Location Attributes	
Response Time	The amount of time before an asset/resource is capable of meeting its full performance, in response to a request by a Service Provider to shed load.
Capacity Type	Type of Capacity
Capacity Type description	Description of the Type of Capacity
Nominal Capacity	Nominated load

Attribute Name	Description
Offer Commit Status.	Commitment status of offer Product-specific commitment status types included with offer. Examples include: economic, emergency, must-run, not participating, outage run status, override status, etc. Also referred to as "opt-in" or "opt-out" for existing Demand Response Programs.
Resource Type	Type of Resource Examples are: load reduction (curtailable or interruptible load), generation, combination, DG, renewable, storage, etc.
Resource Qualification Test Date	Date the Resource demonstrated its ability to deliver a product or service
Requalification Test Date	Date the Resource will retest its ability to deliver a product or service
Enrollment End Date	Date of Termination of Enrollment
Enrollment Status	Status of the Enrollment for the Resource

Sequence Diagram



REQ.17.3.1.4.3.3 Register DR Resource

Description

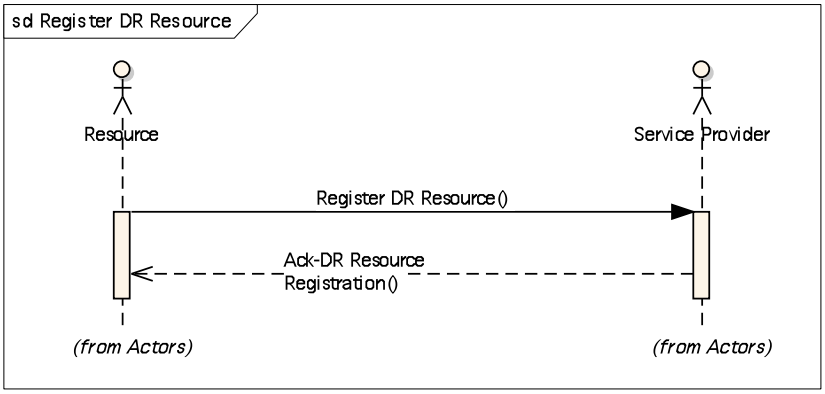
A party with ownership, controlling interest, or administrative responsibilities for a DR Asset or DR Resource that communicates status-related operational information about the DR Asset or DR Resource to a Service Provider. For example,

the owner of a DR Resource or Asset may wish to declare their inability to shed load (an outage) due to summer shutdown or may wish to reduce the available capacity of a resource/asset due to equipment maintenance or other causes.

Data Requirements

The Data Requirements are the same for Register / Enroll DR Resource and Update DR Resource.

Sequence Diagram



REQ.17.3.1.4.3.4 Remove DR Resource

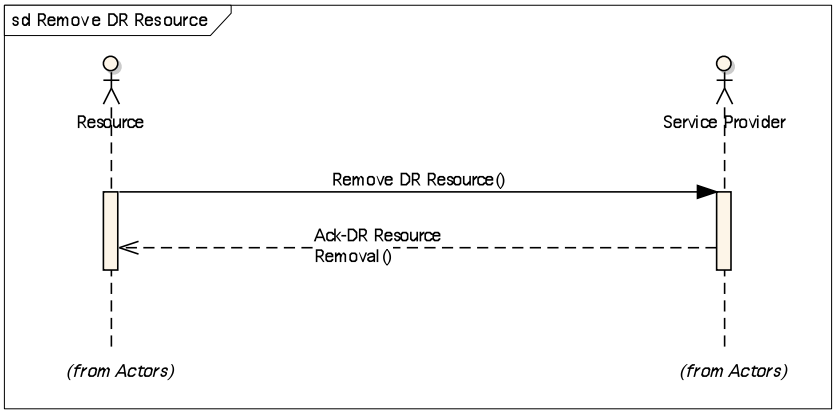
Description

When a DR resource is no longer available permanently for DR purpose, it needs to be removed from the DR program for that customer so that it will be accounted for DR event planning.

Data Requirements

Attribute Name	Description
Resource ID	Identifier assigned to the Resource that is removed.
Program Identifier	The identifier of the program
Enrollment End Date	Date of Termination of Enrollment
Enrollment Status	Status of the Enrollment for the Resource (Set to 'REMOVE')

Sequence Diagram



REQ.17.3.1.4.4 Administrate DR Asset (Direct)

REQ.17.3.1.4.4.1 Register DR Asset

Description

The DR Asset registration process must capture key identifiers to enable accurate tracking of DR assets and their capabilities. A requirement for a System and Market Operator, Load Serving Entity, Service Provider, or other entity facilitating the registration process (hereinafter referred to as DR Asset Administrator) is to track assets. This is done through DR asset registration and association of physical DR assets to DR Resources to recognize the asset and its potential contribution as part of a DR Resource. The DR Asset Administrator ultimately administers the DR Asset registration process to recognize DR Assets that can serve as part of a DR Resource, although the Customer may be party to the registration process.

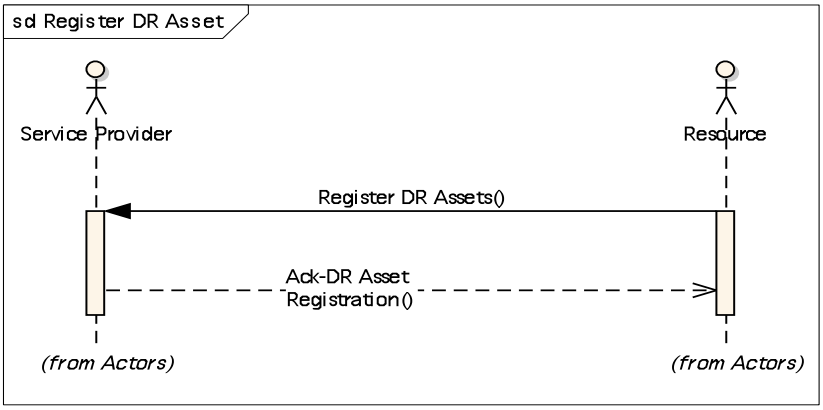
Data Requirements

Attribute Name	Description
Asset ID	The unique identifer of the asset
Program Identifier	The identifier of the program
DR Asset Group ID	Grouping of Assets that can respond to the same DR Signal within a DR Resource. (See DR Resource Specification)
Asset Operator ID	The identifier of the business entity that operates the DR assets. This is the entity that has physical control of the asset and control of the capability to participate in DR Events.
Asset Operator Name	The name of the business entity that operates the DR assets. This is the entity that has physical control of the asset and control of the capability to participate in DR Events.
Asset Owner ID	The Identifier of the business entity that owns the DR assets (entity that has the right to use or transfer use of the asset).
Asset Owner Name	The Name of business entity that owns the DR assets (entity that has the right to use or transfer use of the asset).
Location	The location of a Resource defined by one or more attributes:
Service Location ID	Identifier assigned to the Service Location
Address1	Address line 1

Attribute Name	Description
Address2	Address line 2
City	City
State/Province	State or Province two-letter code
Zip/Postal Code	Zip or Postal Code
Country	Country
GPS Coordinates	Latitide and longitude
Weather Station	Weather Station code associated with the Service Location
Zone ID	Identifier assigned to the Zone in which the Service Location is located
Zone	Name of the Zone in which the Service Location is located
Electrical Node ID	Identifier assigned to the Electrical Node at which the Service Location is connected
Electrical Node Name	Name of the Electrical Node at which the Service Location is connected
Electrical Node Type	Type of Electrical Node at which the Service Location is attached
PNode	Name of the Price Node associated with the Service Location
PNode ID	Identifier assigned to the Price Node associated with the Service Location
Effective Enrollment Date	Effective Start Date for the Enrollment (Registration)
Enrollment Status	Status of the Enrollment for the Asset
Offer Commit Status	Commitment status of offer Product-specific commitment status types included with offer. Examples include: economic, emergency, must-run, not participating, outage run status, override status, etc. Also referred to as "opt-in" or "opt-out" for existing Demand Response Programs.
DR Asset Physical Capabilities	Asset Capabilities include Ramp Rates and Capacity.
Ramp Rate Value	Ramp Rate associated with the selected Ramp Rate Type for the selected Ramp Rate Segment and Ramp Rate Direction
Capacity Type	Type of Capacity

Attribute Name	Description
Capacity Type description	Description of the Type of Capacity
Nominal Capacity	Nominated load
Asset Manufacturer	Manufacturer of the Asset
Asset Model	Model Identifier of the Asset assigned by the Manufacturer
Asset Version	Model Version Identifier assigned by the Manufacturer.
Asset Manufacture Date	Date of Manufacture of the Asset
Asset Type	Type of Asset. Examples are: load reduction (curtailable or interruptible load), generation, combination, DG, renewable, storage, etc.
DR Resources	The identifier of DR resources that the DR Assets belong to. An Asset can associate with multiple Resources, but with only one Resource for a DR Program.

Sequence Diagram



REQ.17.3.1.4.4.2 Update DR Asset

Description

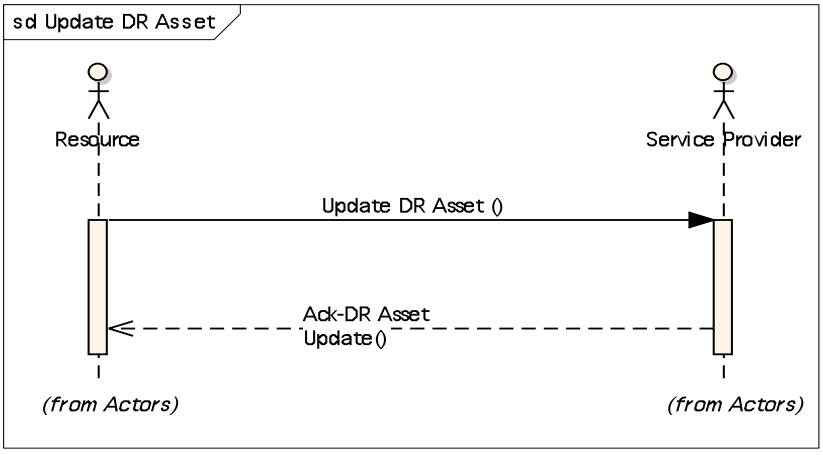
Once a DR asset registration is completed, changes to elements of the registration may be required or desired. After identifying the specific required modification and verifying the authorization to perform the update, each of the considerations identified in the DR Asset registration step should be evaluated and utilized, where necessary, during the update of the DR Asset information. The ability to update DR Asset information helps to ensure the asset information on record is current and complete.

Parties that are privy to and rely on the update should be notified of updates as soon as practicable after they are made. Additionally, these parties should have access to review and, in some cases, to approve/disapprove the update(s).

Data Requirements

The Data Requirements are the same for Register / Enroll DR Asset and Update DR Asset.

Sequence Diagram



REQ.17.3.1.4.4.3 Remove DR Asset

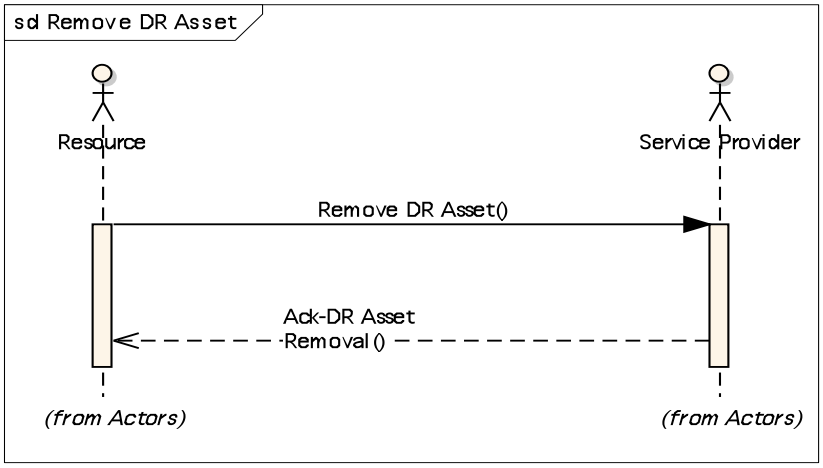
Description

Removing a DR Asset must take into account any DR Resource long term commitments in System Operator programs and contractual obligations with Service Providers or Load Serving Entities. In addition, applicable regulatory agency filings and approvals must be considered prior to removing a DR Asset from a DR program.

Data Requirements

Attribute Name	Description
Asset ID	The unique identifer of the asset
Program Identifier	The identifier of the program
Enrollment End Date	Date of Termination of Enrollment
Enrollment Status	Status of the Enrollment for the Asset ('REMOVE')

Sequence Diagram



REQ.17.3.1.4.5 DR Bidding

Description

Demand Response Bidding occurs after the DR Assets and Resources that are to comprise the desired bid have been registered and a bid or an offer is to be formed. The DR Bidding use case has two sub-use cases, depending on the type of bid to be developed for submission: a bid to supply (i.e., an offer), or a bid to buy. The entity operating the DR bidding program (the Bid Receiver) receives bids from participants (the Bidders). The Bidder may be a Customer bidding with either an energy retailer (e.g., LSE, ESP), a Service Provider (e.g., CSP, DRP), or a power marketer (i.e., wholesale market participant). The Bidder may also be a Service Provider bidding up to a LSE or power marketer.

Before the start of the bidding process, it is assumed that DR Resources available for selection are already registered to provide the physical resource participating in the DR Bidding program. It is also assumed that the bidder has already registered to bid with the bid receiver and has been informed on the appropriate timing and parameters for bid participation. The DR bidding process starts with the decision of the Bidder to develop a bid for submission. The Bidder submits its bid to the Bid Receiver within the appropriate time window and following set guidelines for bidding. The Bidder receives information on the outcome of the submitted bid from the Bid Receiver, who notifies of the bid outcome (e.g., a resource award or other DR commitment).

Examples of retail DR Bidding programs include:

- Demand Bidding
- Capacity Bidding

REQ.17.3.1.4.5.1 DR Bid to Supply (Retail Offers)

Description

The Bid Receiver opens the forum/venue for receiving an offer. (This may include initiating the bidding process by sending initial information to Bidders indicating parameters of acceptability for bids to be made). The Bidder communicates an offer to supply a specified product/service and the pricing or other incentive structure the bidder is willing to accept for DR. (This may be as simple as the customer sending a response back to the Bid Receiver that accepts or rejects the initial bid sought, or may involve more complex bid structuring).

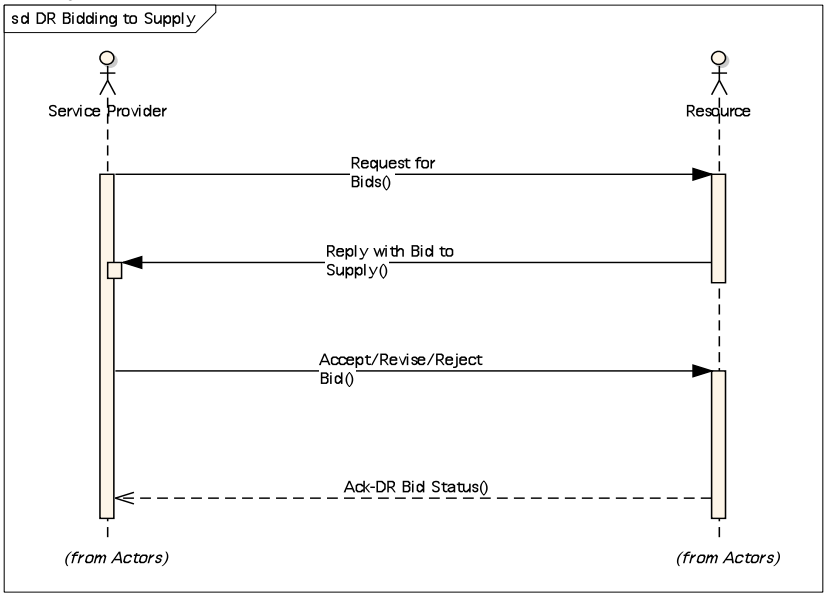
Each offer will have a clearly specified product or service that is being bid and the pricing/incentive structure being offered. The bidder also nominates the amount of and nature of supply being offered, the DR Resource to physically provide the service, and other physical parameters affecting resource availability and capability, in addition to the identity (or ID) of the bidder and resource(s) that comprise the bid.

The Bid Receiver reviews bids (offers) received and clears them, notifying the bidders of the outcome.

The Bidder receives the notification of awards or resource commitments and uses the information internally in preparation for DR Resource Dispatch.

Sequence Diagram

(Note, the Bid in the followign sequence diagram is an offer to supply)



REQ.17.3.1.4.5.2 DR Bid to Buy

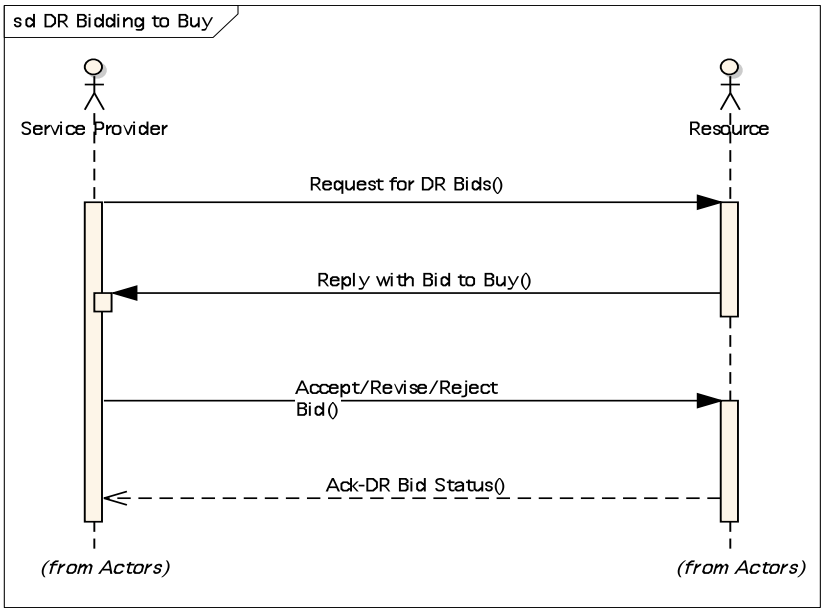
Description

The Bid Receiver opens the forum/venue for receiving a bid. (This may include initiating the bidding process by sending initial information to Bidders indicating parameters of acceptability for bids to be made). The Bidder communicates a bid to buy a specified product/service and the pricing or other incentive structure the bidder is willing to pay to avoid DR. (This may be as simple as the customer sending a response back to the Bid Receiver that accepts or rejects the initial bid sought, or may involve more complex bid structuring).

Each bid will have a clearly specified product or service that is being bid for purchase and the corresponding pricing structure that is acceptable to the Bidder. The Bidder also includes the quantity of product/service in the bid to buy, and specifies any DR Resource(s) that can physically substitute for the product/service in the event the bid to buy is not cleared (i.e., the bidder is unwilling to pay more than the going/market outcome price for the product/service). Other information submitted include physical parameters affecting resource availability and capability, in addition to the identity (or ID) of the bidder and resource(s) that comprise the bid.

The Bid Receiver reviews bids received and clears all bids, notifying the bidders of the outcome. The Bidder receives the notification of resource commitments and uses the information internally in preparation for DR Resource Dispatch.

Sequence Diagram



REQ.17.3.1.4.6 Execute DR Event

The execution of a DR event takes different forms depending on operational situation and the type of DR programs being executed. Typically, they fall into one of the following four use cases, see Figure 5:

1. Advanced DR Notification
2. Broadcast DR Message (price plus information)
3. DR dispatch instruction
4. DR direct load control.

Operational considerations for DR event execution are also associated with DR programs where direct load control or dispatching instructions are carried out.

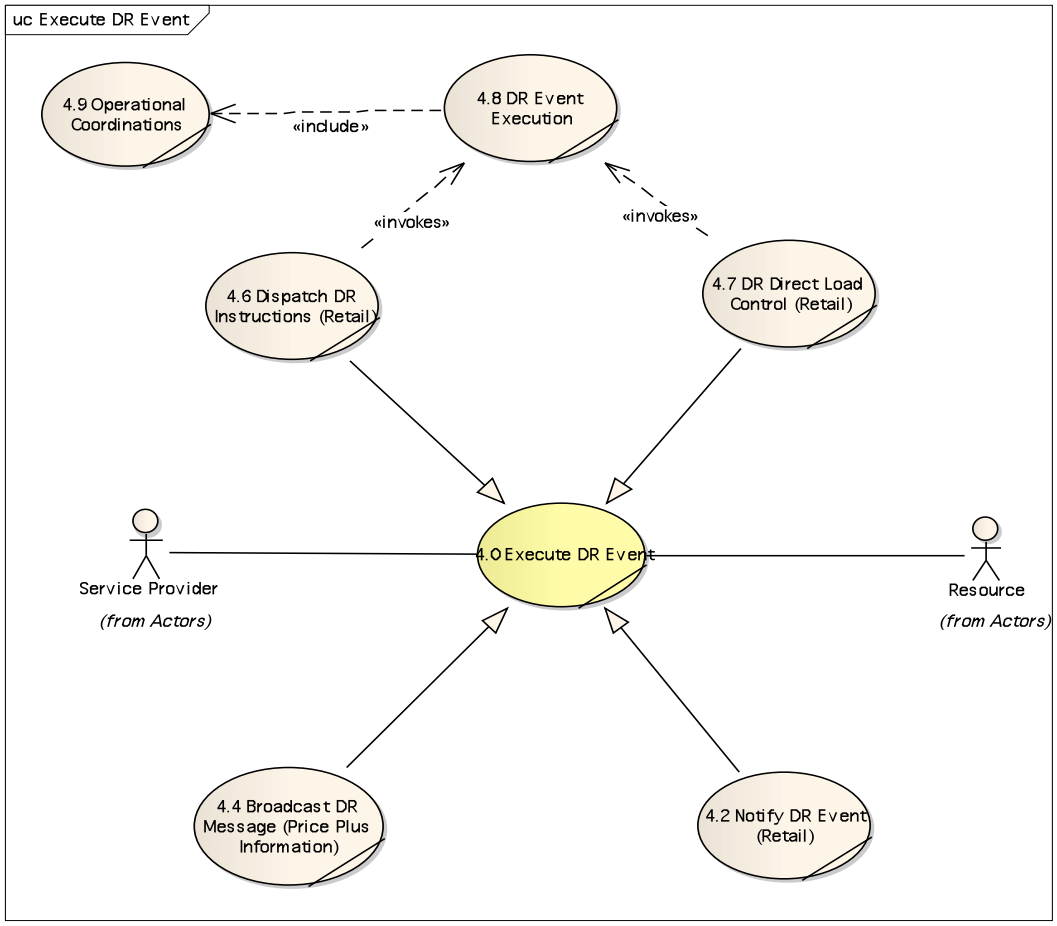


Figure 5. Execute DR Events

REQ.17.3.1.4.7 Notify DR Event (Retail)

REQ.17.3.1.4.7.1 Advanced Notification for DR (Retail)

Description

This is used by the Service Provider to send the DR Event notification (i.e., DR signal) to the DR Resource.

The Notify DR Event Message applies to one of three types:
Broadcast DR Message (Price Plus Information)
Dispatch DR Instructions for Objectives (Retail)
DR Direct Load Control (Retail).

The message content specific to each of these types is defined in their respective sections below.

Data Requirements

The following are the data requirements that are common to all of the Event Message Types.

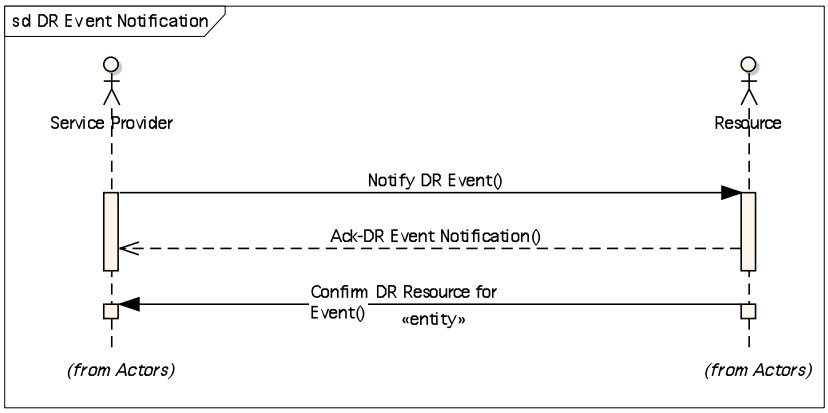
Attribute Name	Description
Program ID	Program Identifier
Program Name	Name of the Program
Service Provider ID	Identifier assigned to the Service Provider
Event ID	Identifier assigned to the Event
Event Modification Number	A modification number for the DR event. This is used to indicate if the DR Event has been modified by the Utility. Each time it is modified, this number is incremented.
Area of Event Notice Applicability: The area affected by the Demand Response Event can be defined by a Location attribute (point location or area) or is applicable to a Resource or to an Asset for Direct Load Control.	
Resource ID	Identifier assigned to the Resource
Asset ID	The unique identifer of the asset
Location can be identified by any of the following:	
Service Location ID	Identifier assigned to the Service Location
Address1	Address line 1
Address2	Address line 2
City	City
State/Province	State or Province two-letter code
Zip/Postal	Zip or Postal Code

Attribute Name	Description
Code	
Country	Country
GPS Coordinates	Latitide and longitude
Weather Station	Weather Station code associated with the Service Location
Zone ID	Identifier assigned to the Zone in which the Service Location is located
Zone	Name of the Zone in which the Service Location is located
Electrical Node ID	Identifier assigned to the Electrical Node at which the Service Location is connected
Electrical Node Name	Name of the Electrical Node at which the Service Location is connected
Electrical Node Type	Type of Electrical Node at which the Service Location is attached
PNode	Name of the Price Node associated with the Service Location
PNode ID	Identifier assigned to the Price Node associated with the Service Location
The following are other attributes applicable to all DR Event Messages.	
Deployment Type	Type of Deployment. Examples are: Advanced (Normal), Immediate, Audit/Test.
Simple Signal Levels	Used as an alternate and simplified representation of the DR signal, whether it be price based or a dispatch. Takes on a small number of finite levels such as NORMAL, MODERATE, and HIGH, SPECIAL

Attribute Name	Description
Criticality Level	This field defines the level of criticality of this event. The action taken by load control devices for an event can be solely based on this value, or combination with other Load Control Event fields supported by this device. For example, additional fields such as Average Load Adjustment Percentage, Duty Cycle, Cooling Temperature Offset, Heating Temperature Offset, Cooling Temperature Set Point or Heating Temperature Set Point can be used in combination with the Criticality level. Criticality Level — Level Description — Participation 0 — Reserved 1 — Green — Voluntary 2 — 1 — Voluntary 3 — 2 — Voluntary 4 — 3 — Voluntary 5 — 4 — Voluntary 6 — 5 — Voluntary 7 — Emergency — Mandatory 8 — Planned Outage — Mandatory 9 — Service Disconnect — Mandatory 0x0A to 0x0F — Utility Defined — Utility Defined [4]
Baseline Dates	Dates of days used to calculate the Energy Baseline
Baseline Exclusion Dates	Dates of days Excluded from the calculation of the Energy Baseline
Energy Baseline Value	Calculated Energy Baseline
Energy Baseline Timestamp	Timestamp of Energy Baseline
Deployment Period (Interval): The deployment period that is communicated to a Resource or Asset is an interval contained within the Start or End Time of the Event, but not necessarily for the entire Event.	
Event Start Time	Time of Start of deployment period for Event
Event End Time	Time of End of deployment period

[4] Requirement as defined by the ZigBee Smart Energy Profile™ 2.0 Technical Requirements Document

Sequence Diagram



REQ.17.3.1.4.7.2 Update a DR Event (Retail)

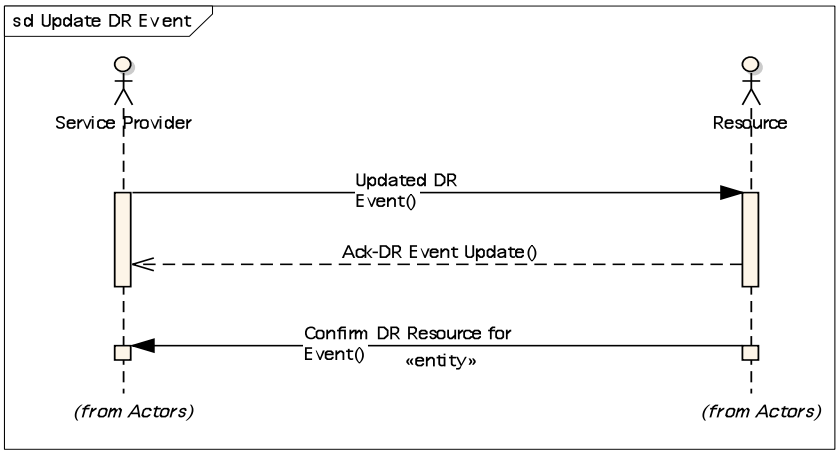
Description

This is used to update a DR event that has been previously notified. The requirements for this use case are the same as those for the "Advanced Notification for DR" use case.

Data Requirements

Attribute Name	Description
Event	See the "Advanced Notification for DR" use case.
Event Modification Number	This is Modification number of the DR event. It is used to indicate that the DR Event has been modified by the Utility or Service Provider. Each time a DR Event is modified, this number is incremented.
Modification reason code	The reason the event was modified.

Sequence Diagram



REQ.17.3.1.4.7.3 Cancel a DR Event (Retail)

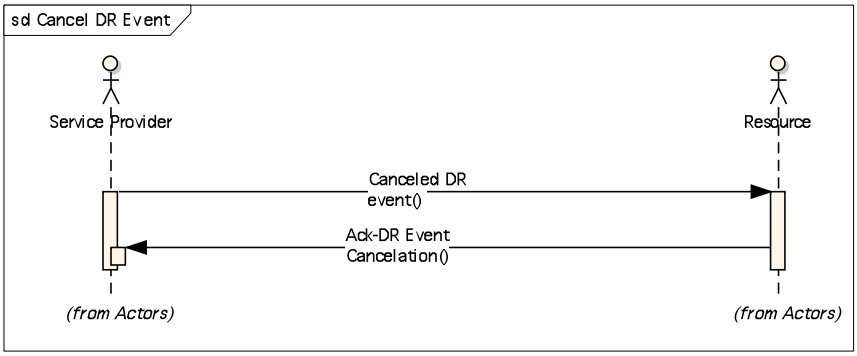
Description

This is used by the Service Provider to notify the DR Resource that a DR Event is being cancelled. It should only be executed if a DR Resource has previously received notification of a DR Event and that event has subsequently been cancelled.

Data Requirements

Attribute Name	Description
Modification reason code	The reason the event is being cancelled.
Event Status	Status of the Event
DR Event Identifier	An identifier for the event that is being cancelled.
Effective date/time	The date and time a cancellation takes effect.

Sequence Diagram



REQ.17.3.1.4.7.4 DR Resource Confirmation (Retail)

Description

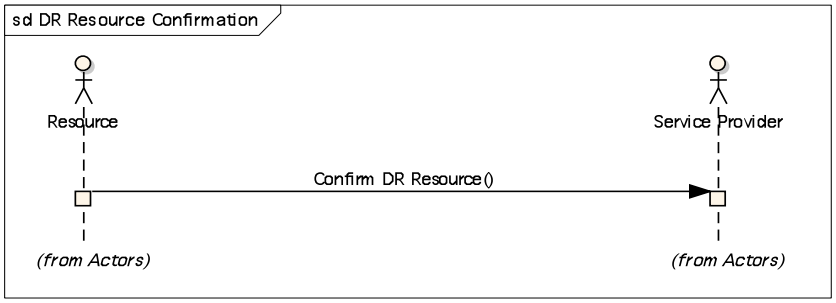
This is a confirmation message that is sent by a DR Resource to the Service Provider as a result of receiving a DR Signal form the Service Provider. It may be used as an acknowledgement of the receipt of the DR signal, but it may also contain various information used to signify how the DR Resource will respond to the DR Signal.

Any changes to the Resource or Asset that may impact participation or performance for the Event (such as Location and Load Profile) shall be provided through the Update Resource or Update Asset Messages.

Data Requirements

Attribute Name	Description
Resource ID	Identifier assigned to the Resource
Asset ID	The unique identifer of the asset
Exception Conditions	This is used to report that the load controller may not behave as commanded because of a variety of conditions including: • Faults in device • Customer override.
Load Control State	The state of the load, which includes both commanded states and user settings. This may include a schedule of future states if a particular control algorithm for the load controller is being executed.
Operational Constraints	Operational Constraints at run time may differ from those provided at Enrollment, and will be applicable only to the time interval of the Event for this Resource or Asset.
Constraint Type	Type of operational, schedule or offer constraint
Constraint Interval	The timeframe over which the constraint type applies.
Constraint Value	Value of the Constraint Type and Interval
Offer Dispatch Status	Dispatch Status of Offer a.k.a. as “Opt-in” or “Opt-out” in existing programs.

Sequence Diagram



REQ.17.3.1.4.8 Broadcast DR Message (Price Plus Information)

Description

Demand Response programs are designed to address different power system concerns caused by the imbalance between generation, transmission and consumption, or environmental concerns. Some DR programs are conducted on a voluntary basis, where the customer can opt to maintain the level or load. Some DR programs are mandatory, where either the customer loads will be curtailed under certain conditions or the customer will incur financial penalties for noncompliance.

In retail market, certain "DR Messages" can be broadcasted to DR resources either directly or through Service Providers. DR Message is defined as information about the DR signals that may affect the demand behaviors of the energy consumers. Obviously, the main component of the DR Message is the pricing information. However, there are other attributes of energy being delivered that may be of interest to energy consumers and could be included in the DR Message.

Based on the OpenADR discussion, the broadcasting function is mainly used for volunteer or non-mission critical DR messages. Therefore, message acknowledgement or confirmation is optional.

DR Source of Power/Generation

"DR Message" also can be source of power or generation. ANSI C12.19-2008 defined the following source of power/generation in Standard Table 12.

Precondition:

The DR Service Provider sends the DR message to service providers. In the case of DR pricing, the DR Service Provider calculates the price

per location and communicates the appropriate price associated with the DR product to service providers.

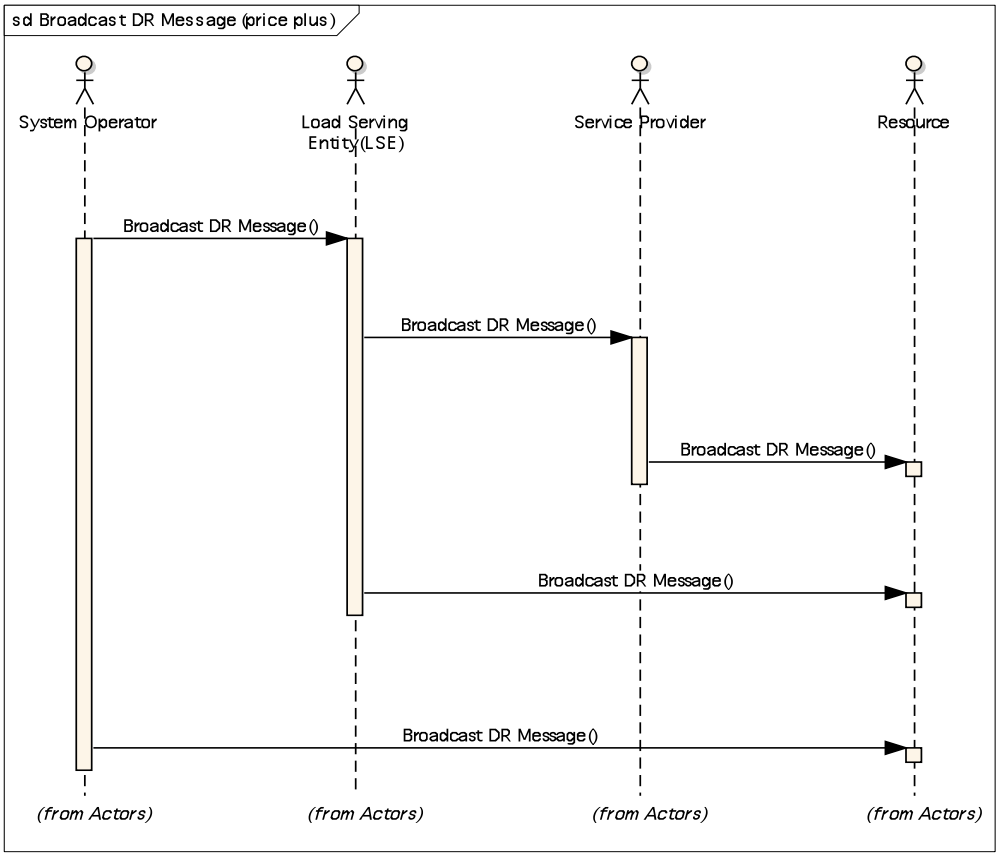
Post Condition:

DR Resources received the DR pricing information, and may or may not act based on the DR agreement or contract.

Data Requirements

Attribute Name	Description
Currency	Economic unit of exchange in which the total price and price components are stated (e.g. dollars, euros)
Product Price	The sum of all Price Component Values for a given product (Total Price).
Product Price Factor	Terms of use attribute of Product Price Examples: Price absolute, Price relative, Price multiplier
Unit of Measure	Attribute of Product Identifier
Delivery Time	Time at which the product is available for physical consumption
Delivery Interval	The duration over which the product is available for physical consumption
Market Product (Product Type)	Market Product Product types include the following: energy, capacity, regulation, operating reserves (spinning or non-spin).

Sequence Diagram



REQ.17.3.1.4.9 Dispatch DR Instructions (Retail)

Description

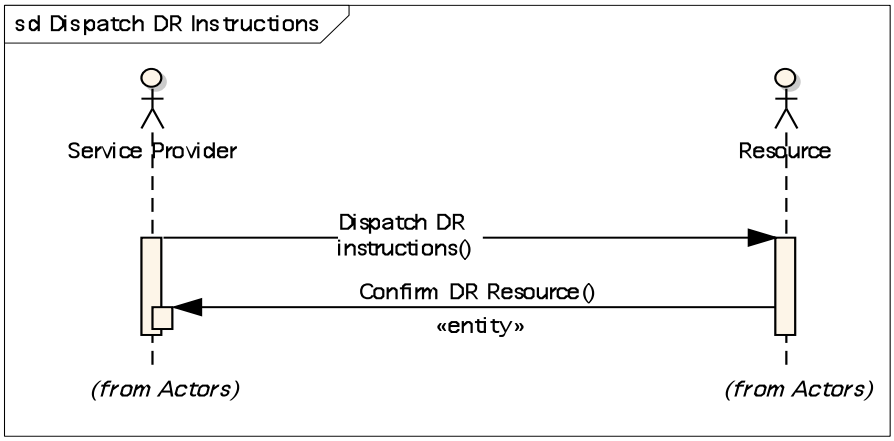
This interaction is used to dispatch DR Resources. This type of interaction is used when the Service Provider needs to achieve specific objectives from the DR Resources during DR events. This means that specific instructions will be given to the DR Resource with objectives (e.g. shed 100 kW) for the load profile of the DR Resource.

Note that for the retail use cases, a Dispatch is considered a special type of DR Notification, and thus, it is very similar in nature to the requirements given for that interaction.

Data Requirements

Attribute Name	Description
DR Dispatches for DR Objective based messages are of three types. • LOAD LEVEL • LOAD AMOUNT • LOAD PERCENTAGE	
For Load Level: Load Level Value	Value of the load level to be achieved based on a set of enumerated values. (e.g. moderate, high, etc)
For Load Amount: Deployment MW	Deployment quantity expressed as an Absolute
For Load Percentage: Deployment MW	Relative Deployment quantity expressed as %.

Sequence Diagram



REQ.17.3.1.4.10 DR Direct Load Control (Retail)

Description

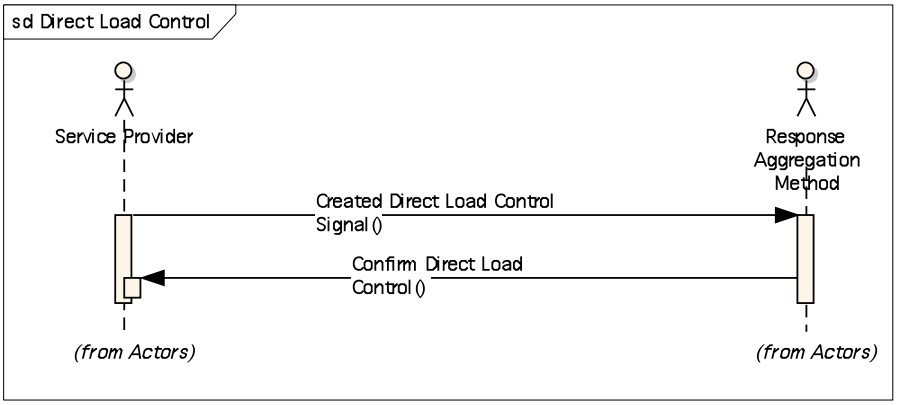
This use case covers direct interactions between the DR Service Provider and a specific DR Asset for the purposes of putting that asset into a specific load control state (e.g., to turn it on or off). In this case, the DR Asset is a DR Resource with only one DR Asset, and thus, the interaction is directly with the DR Asset.

See REQ.17.3.1.4.11.3, DR Execution - Direct Load Control (DLC) for more details.

Data Requirements

Attribute Name	Description
Asset ID	The unique identifer of the asset (Note: Direct Load Control messages are applicable only to Assets)
Status Check	A signal to require the DR resource status to be sent back. (Only applicable to Direct Load Control)
DR Control Command: Direct Load Control Type	The type of DR Direct Load Control Command: e.g. Set Point, Open/Close, Heating Temperature - offset/setpoint, Cooling Temperature - offset/setpoint, Load adjustment offset
DR Control Command: Direct Load Control Value	Value associated with the Direct Load Control Type.
Event Start Time	Time of Start of deployment period for Event
Event End Time	Time of End of deployment period
Duty Cycle	"Duty Cycle : Defines the maximum On state duty cycle as a percentage of time. Example, if the value is 80, the device would be in an "on state" for 80% of the time for the duration of the event. Range of the value is 0 to 100. A value of 0xFF indicates the field is not used." (from SEP2.0) [4]
Event Control	Event Control options for randomized start or end times: 1= Randomize Start time, 0=Randomized Start not Applied 1= Randomize End time, 0=Randomized End not Applied. (from SEP2.0) [4]
Device Class	Enumeration representing the Device Class to apply the current Load Control Event.[4]

Sequence Diagram

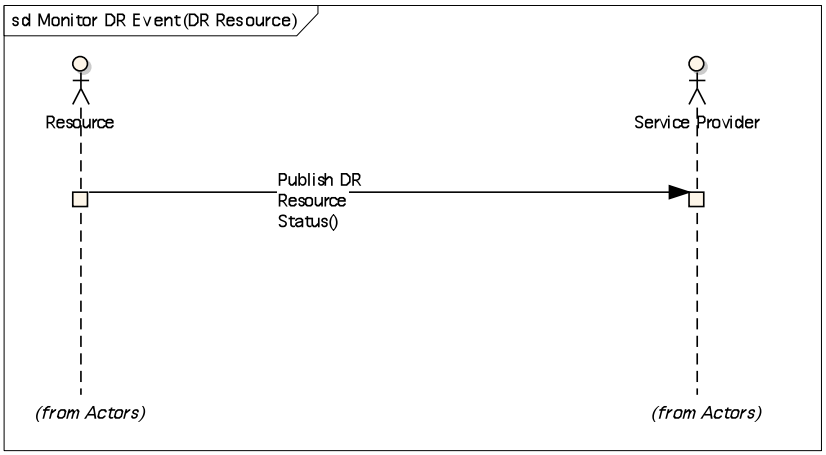

sd Direct Load Control
Service Provider
Response Aggregation Method
Created Direct Load Control Signal()
Confirm Direct Load Control()
(from Actors)
(from Actors)

REQ.17.3.1.4.10.1 Monitor DR Event (DR Resource)

Description

This interaction is used to monitor a DR Resource's behavior. It may be executed as a result of the DR Resource receiving a DR signal or it may be conducted continuously.

Sequence Diagram

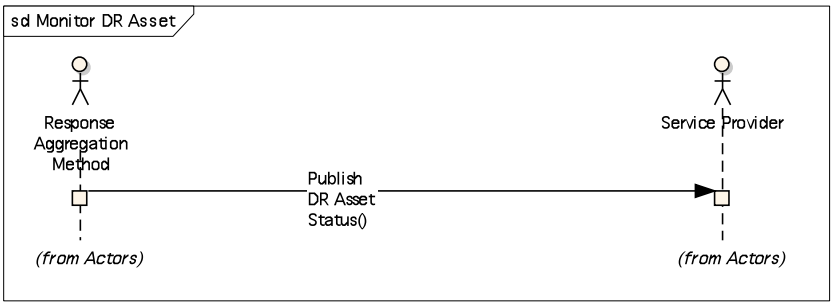


REQ.17.3.1.4.10.2 Monitor DR Event (DR Asset)

Description

This interaction is used to monitor the state of a DR Asset. It may be executed as a result of the DR Asset receiving a DR signal or it may be conducted continuously.

Sequence Diagram



REQ.17.3.1.4.11 DR Event Execution

Demand Response is deployed for economic or a reliability purposes. At high penetration levels, demand response has to be integrated with the power supply scheduling process, and it may impact the distribution grid operation and reliability, and perhaps the transmission grid operation and reliability. Thus it is important to include the required considerations for the grid and system level operations when developing DR Use Cases and DR signal standards. Such impacts may not be significant at low penetration levels; however, proper considerations must be given to support scalability and expandability for future deployments.

Power system operates based on a real-time balancing of supply and demand. To economically schedule the supply, an accurate load forecast is needed. Traditionally, load forecast was generated using the historical consumption patterns, weather forecast and other similar parameters. With the potential of high-penetration of DR, it will be necessary to incorporate the planned or forecasted DR levels into the load forecast. Also, DR capabilities can be used to support the power system capacity or emergency supply (ancillary service) needs. Such services require proper scheduling and monitoring capabilities.

A demand response event may be initiated by a power system operator in response to a reliability event, e.g., loss of a generating station causing a lack of supply to meet demand, or an uncontrolled set of PEVs overloading of a distribution transformer. A demand response event may also be initiated by utility operational systems based on economic considerations, e.g., reducing or shifting peak load at the system level or at specific feeder or facility. Demand response may also be initiated by a customer in response to a market pricing signal

Considering that the distribution grid in the US is typically a three-phase imbalance circuit, i.e., many customers are on a single-phase or two-phase of the three-phase system. Thus significant changes in customer load patters could result in undesirable imbalanced conditions on a feeder. Also, load pickup following the termination of a major DR event could possibly cause overloads and other operational problems, if the load pickup is not properly scattered/managed.

The following provides three representative use cases to highlight some the key interactions. These include:

- Dynamic Price-based DR
- Notification-based DR
- Direct Load Control

REQ.17.3.1.4.11.1 DR Execution – Retail Time Pricing (RTP)

Description

Provide real-time or dynamic pricing (RTP) to retail customers so that customers can vary their demand based on pricing signals. RTP represents retail electricity rates that vary as a function of time

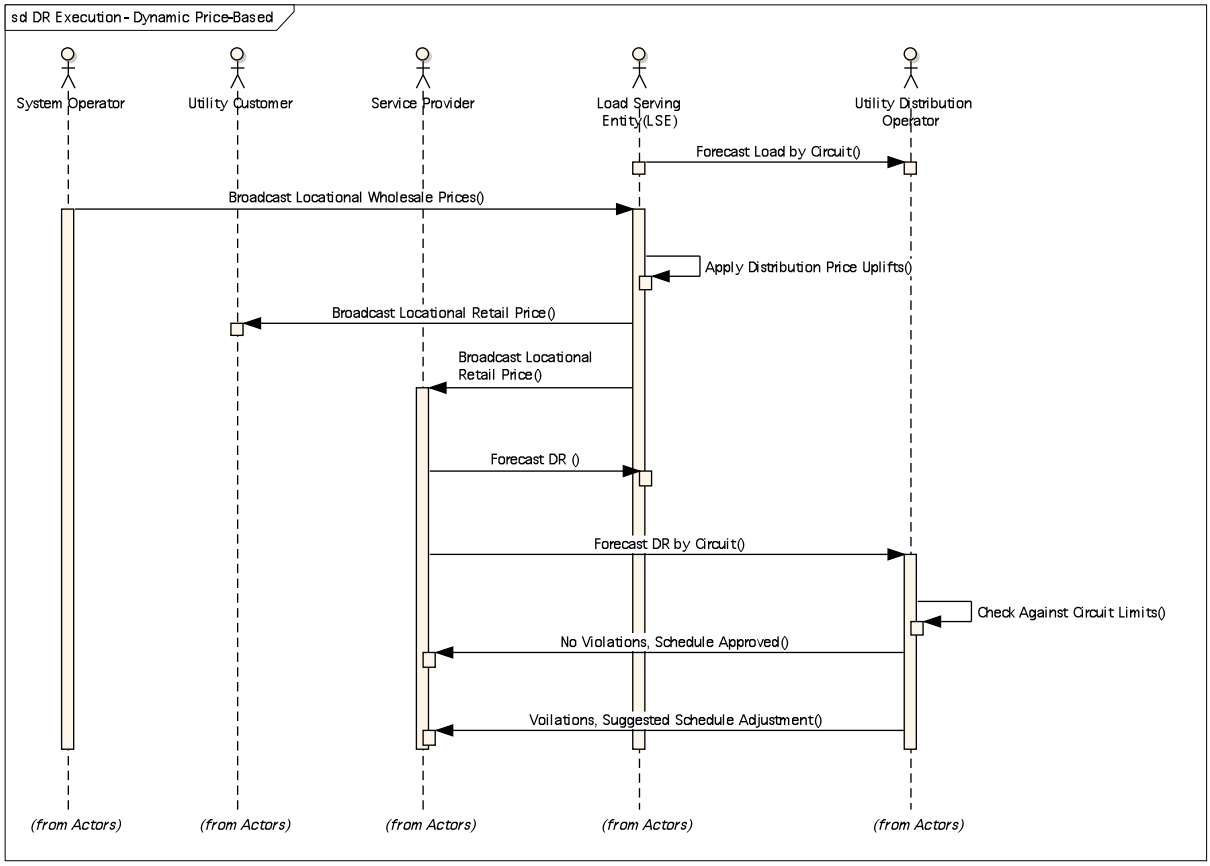
Traditionally, retail tariff has based on a fixed or tiered rate structure with possible considerations of static rates for pre-established time of use (TOU) conditions. Real time or dynamic pricing (RTP) represent retail electricity rate that could vary as a function of time and is intended to modify demand. It requires interval metering for accurate billing based on time-varying prices. A number of states have implemented RTP or other dynamic pricing tariffs for large customers. With a broader deployment of advanced meters, RTP rates may become more common nation-wide.

The scenario presented here represents a case where a location-dependent real-time retail pricing for energy is established based on the Locational Marginal Price (LMP) for that location. LMP values are typically established by an ISO (for regions covered by an ISO/RTO) on a day-ahead (hourly resolution) and real-time basis, typically on a five minute resolution. For the RTP, it may be appropriate to use the real-time LMP as the basis for computing the retail dynamic tariff. However, decisions should be made on the time and the spatial resolution of the RTP. For example, an hourly RTP averaging the five minute pricing values, or a Critical Peak Pricing model to reflect the extreme conditions only, may be adopted. In addition to the energy price, the retail RTP rate may also include the appropriate uplift charges to cover for distribution wire/services charges and for the power loss compensations. Note that the uplift charges are typically subject to a regulatory review and approval.

Special care must be given to the RTP rate design to ensure customer acceptance and adaptation. Also grid operational issues may have to be addressed. For example, during low

LMP (RTP) periods (e.g., at night), certain distribution circuits may get over loaded (congested), with customers shifting consumption, e.g., charging PEVs, to that period. This improves the overall system economy, but may cause circuit congestion. To combat this, some have proposed use of demand charges or an additional incentive payment for load reduction, a locational incentive to relief congestion.

Sequence Diagram



REQ.17.3.1.4.11.2 DR Execution – Notification Based

Description

Notification-based DR is mostly used for economic purposes based on a day-ahead or hours or hour-ahead basis. Notification-based DR may also be used for reliability events when the system operator expects a contingency or operating condition (e.g., congestion or planned outage) on the distribution or the transmission grid that requires a reduction (or an increase) on the load at a given location.

Considering that the business processes for demand response have not yet been standardized across the nations, the following is a representative scenario that captures some of the interactions between the key stakeholders (actors).

At high penetration levels, the DR operation, especially on a day-ahead or hour ahead basis, need to be coordinated with the overall operations and supply scheduling process. As is shown in the Sequence Diagram below, this may require a timely update of the "locational" load forecast and an up-to-date nomination of the DR capabilities. This information may be supplied to the "system" and/or market operator to be incorporated in the overall supply and demand scheduling process. The DR capabilities are specified by the DR Provider to the System Operator based on a DR Program, a price curve, or other nomination protocol. The DR Provider may also inform the Load Serving Entity (LSE) of the locational available DR capabilities.

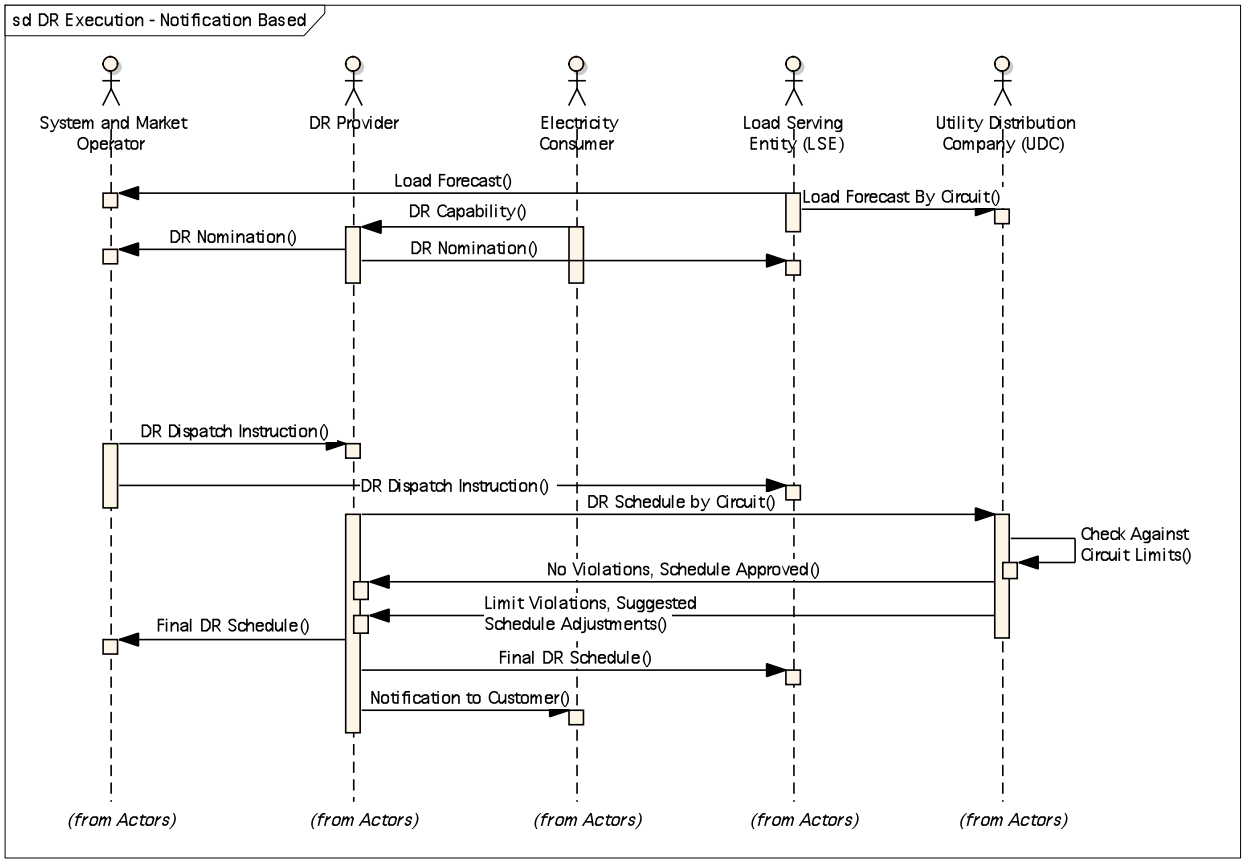
The notification-based DR dispatch process is typically initiated by the System or Market Operator; the process may also be initiated by an LSE or UDO. It is also possible that the DR Provider be the initiator of the DR process based on a market opportunity (economic operation) or based on a pre-established program.

At high DR penetration levels, it is expected that the DR provider will need to clear the DR schedule with the Distribution Grid Operator, the UDO. This is to insure that the high penetration DR has no adverse impact on the distribution grid reliability and power quality, e.g., cause of excessive imbalances, voltage violation, or an overload during load pickup period. The UDO, in a timely fashion, will inform the DR Provider, if the schedule is cleared or requires an adjustment. Please note that if the DR deployed by a utility company that includes both LSE and UDO functions, such coordination is performed within the company's operational

systems (e.g., DRMS, DMS, etc.), or it can be an integral part of the DR scheduling application.

Following the clearing the DR schedule, notifications are sent to customers for DR operation. Under this scenario, the Market Operator and the LSE are also informed of the final DR schedule.

Sequence Diagram



REQ.17.3.1.4.11.3 DR Execution – Direct Load Control (DLC)

Description

Direct-Load Control is typically used for reliability-based events such as contingency and emergency support, supply of balancing energy or other ancillary service. Many of these programs require quick response time, e.g., five minutes or faster, that is practically only possible through a DLC capability. Direct-Load Control may also be used for economic operations, e.g., water heater programs to reduce or shift peak load.

Considering that the business processes for demand response have not yet been standardized across the nations, the following is a representative DLC scenario that captures the interactions between the key stakeholders (actors).

Direct Load Control is typically called for by a system operator, a transmission or distribution operator. It could be also issued by a Market Operator based on an ancillary service DR award, or by an LSE or DRP for an economic purpose. At high penetration levels, DLC operation needs to be coordinated with the distribution grid operator, the UDO.

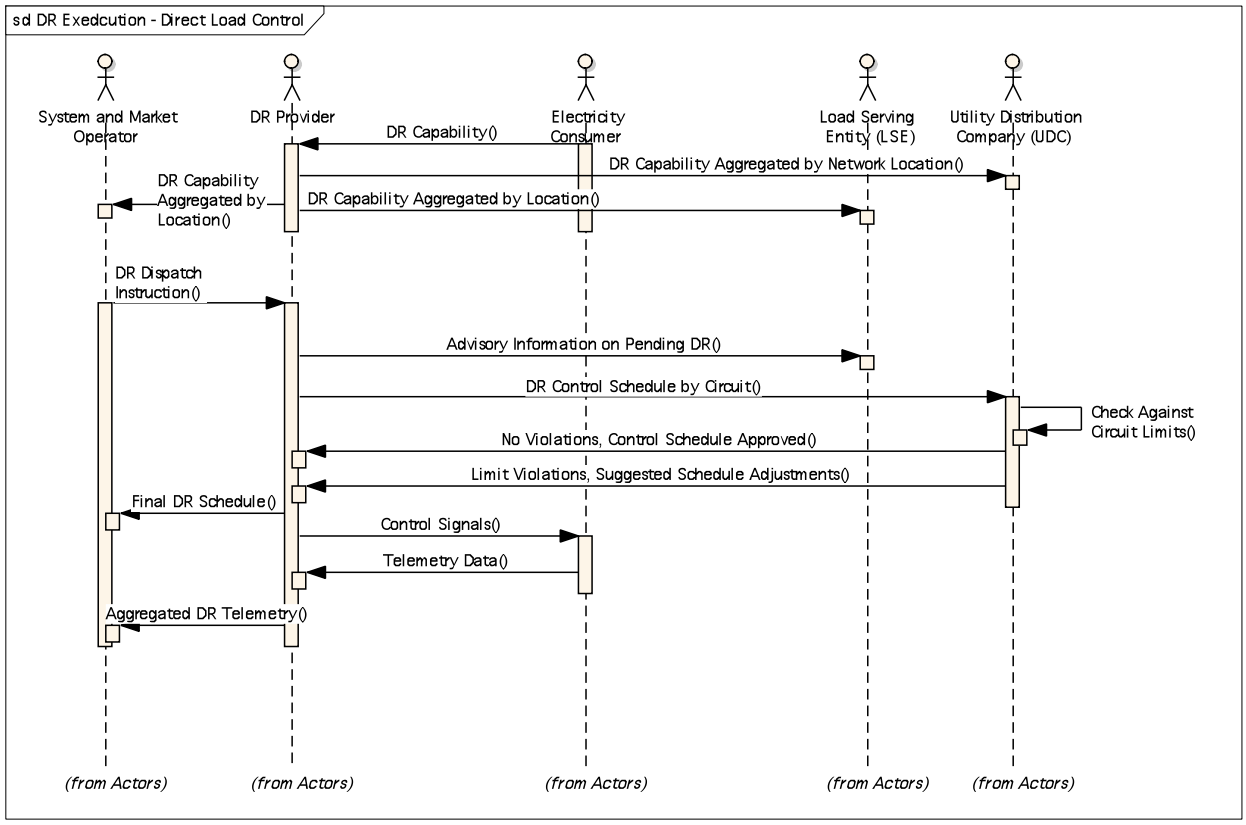
As is shown in the sequence diagram below, the customer DR capabilities are aggregated by location and specified/nominated to the Distribution Grid Operator, Load Serving Entity, and/or to the System/Market Operator. In addition to location, the capabilities may also be aggregated by the DR response time, e.g., four seconds, five minutes, 30 minutes, etc.

The DLC Dispatch process is typically initiated by the Transmission or Distribution Operator. The process may also be initiated by the Market Operator or the LSE. The actual control of the DR resources may be done by the DR provider based on the dispatch signal received.

At high DR penetration levels, it is expected that the DLC activation schedule to be coordinated with the Distribution Grid Operator, the UDO. This is to insure that there are no adverse impact on the distribution grid reliability and power quality, e.g., voltage violation, excessive phase imbalances, or an overload during load pickup period. If the DLC deployed by a utility company such coordination can be accomplished within the company's DR and distribution management systems, or performed as an integral part of the DR control functions.

For a "fast" DR, e.g., provision of ancillary services, a telemetry capability is required to enable the real-time monitoring of the resource condition and its response to the DR control signal.

Sequence Diagram



REQ.17.3.1.4.12 Operational Coordination

Due to the existing differences in the regional retail energy market regulations, wholesale market structure and protocols, and supply and demand conditions, currently there are regional differences in business practices and processes governing demand response. As a result, operational coordination requirements for demand response somewhat vary from region to region, depending on the available retail tariff, retail market structure, available wholesale market for DR and the market mechanics.

The following table summarizes the major roles and responsibilities of the key stakeholders with respect to demand response operation. As can be seen in this table, a significant level of stakeholder coordination is required for an end-to-end DR operation spanning from the wholesale markets to the end-use customers.

Stake Holder	Key Responsibilities
Wholesale Market Operator	• Establish, administer, and operate wholesale demand response programs and markets; • Determine and publish locational prices for wholesale demand response products; • Improve energy market efficiencies (economics) by integrating demand response products and capabilities; • Monitor compliance to wholesale DR instructions and financially settle with the participating stakeholders.
Transmission Grid / System Operator - Balancing Authority	• Monitor and maintain transmission grid reliability, and call upon wholesale demand-side (demand response) capabilities to address contingency/emergency conditions; • Dispatch demand-side capabilities to balance supply and demand, e.g., mitigating impact of variable generation (e.g., wind). • In regions with no organized wholesale energy market, economically dispatch available generation and demand resources including demand response to optimize supply economics.

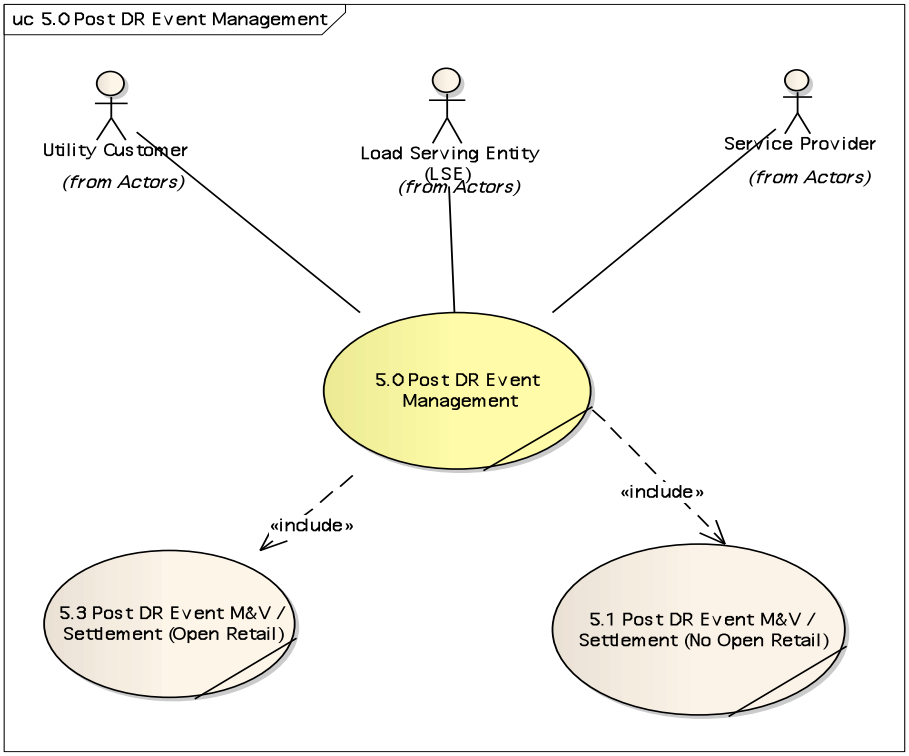
Stake Holder	Key Responsibilities
Distribution Grid Operator – Utility Distribution Company	• Monitor and maintain the distribution grid reliability and the quality of power supply (e.g., voltage levels). Call upon DR to mitigate the distribution contingencies and reliability concerns. • Review and approve the integration of distributed energy resources with the distribution grid. • Assess the operational impact of distributed resources and demand response (DR/DER) on power quality and reliability of the distribution grid, approve high-penetration DR schedules (especially cold-load pickup operation). • Coordinate with the respective Load Serving Entity and Energy Service Providers for the assessment of distribution service and loss compensation charges to retail customers.
Load Serving Entity	• Forecast load and economically schedule supply to meet demand at all times. Incorporate demand response capabilities to improve load factor, reducing/shifting peak load. • Establish and obtain regulatory approval for a fair and unbiased retail tariff for all customer classes. For real-time dynamic pricing (RTP) tariff, apply distribution service, loss compensation and other uplifts to the wholesale locational prices. • Establish and administer demand response and distributed resource management programs including DR tariff. • Meet regional requirements for Renewable Portfolio Standards compliance for power delivery. • Aggregate and schedule DR capabilities in wholesale markets, manage DR programs. • Manage customer metering and billing process.

Stake Holder	Key Responsibilities
Power Marketer	• Forecast load and economically schedule supply to meet demand at all times. Incorporate demand response capabilities to improve load factor, reducing/shifting peak load. • Establish and obtain regulatory approval for a fair and unbiased retail tariff for all customer classes. For real-time dynamic pricing (RTP) tariff, apply distribution service, loss compensation and other uplifts to the wholesale locational prices. • Operate a wholesale and/or retail demand response programs with wholesale and/or retail customers.
Energy Service Provider	• Operate only in regions with competitive retail market • Be an alternative supplier of electric power to end-use customers by offering competitive products, services and prices. • Forecast aggregated load of the enrolled customers by location as required. • Coordinate the power supply with the respective LSE and UDO. • Support demand response programs (DR/DER) for enrolled customers. • Aggregate demand and demand-side capabilities; schedule the aggregated load and DR capabilities in wholesale markets. • Provide for DR telemetry and other monitoring requirements, on a resource or aggregated basis. • Apply the necessary uplifts (e.g., distribution service and loss compensation charges) to the wholesale locational prices. • Meet regional requirements for Renewable Portfolio Standards compliance for power delivery. • Bill and settle with customers for energy supply and DR operation.

Stake Holder	Key Responsibilities
Demand Response Provider	• Offer competitive demand response services to the end-use customers. • Design and manage DR programs, establish pricing structure and signals for DR operation • Aggregate demand and demand-side capabilities; and offer/schedule these capabilities with the respective LSE or the wholesale market. • Provide for DR telemetry and other monitoring requirements, on a resource or aggregated basis. • Bill and settle with customers for energy supply and DR operation.
Electricity Customer	• Subscribe to a DR program, and update DR availability and capability information as appropriate • Maintain DR resources, data communications, telemetry, metering and control devices as required. • Respond to pricing signals, DR notifications, or control signals as appropriate.

REQ.17.3.1.4.13 Post DR Event Management

Post DR event management mainly concerns with the reconciliation of the actual consumption of energy within the duration of a DR event with the expected behavior so that proper financial reward or penalties could be carried out. The NAESB M&V standard for DR defines the requirements for most of the post event management. The following use cases describe post DR event management for three different market types.

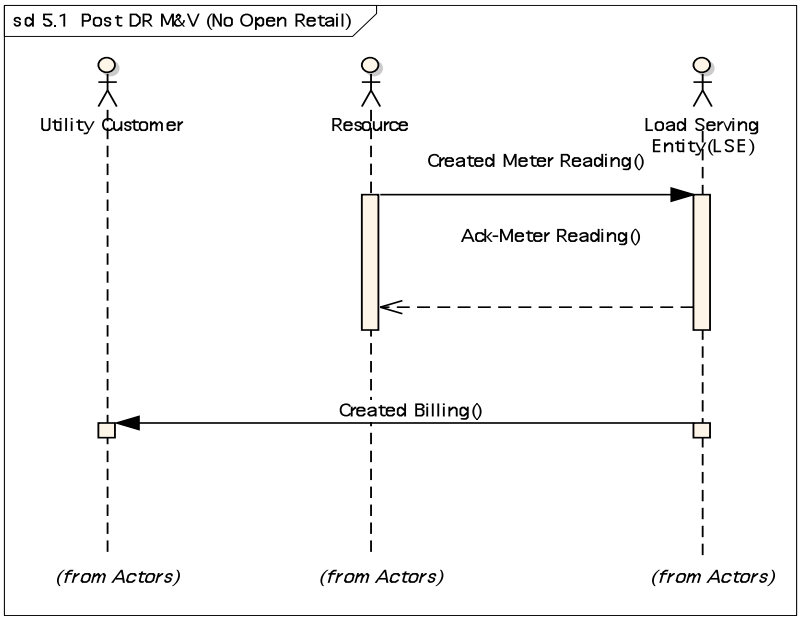


REQ.17.3.1.4.13.1 Post DR Event M&V / Settlement (No Open Retail)

Description

After DR Event has been completed, then Measurement and Verification (M&V) can confirm whether action has been taken or to measure the impact of the response. After the M&V, then the Financial Settlement is calculated and sent to the Electricity Customer[5]. This Use Case covers the scenarios with no Open Retail Markets.

Sequence Diagram



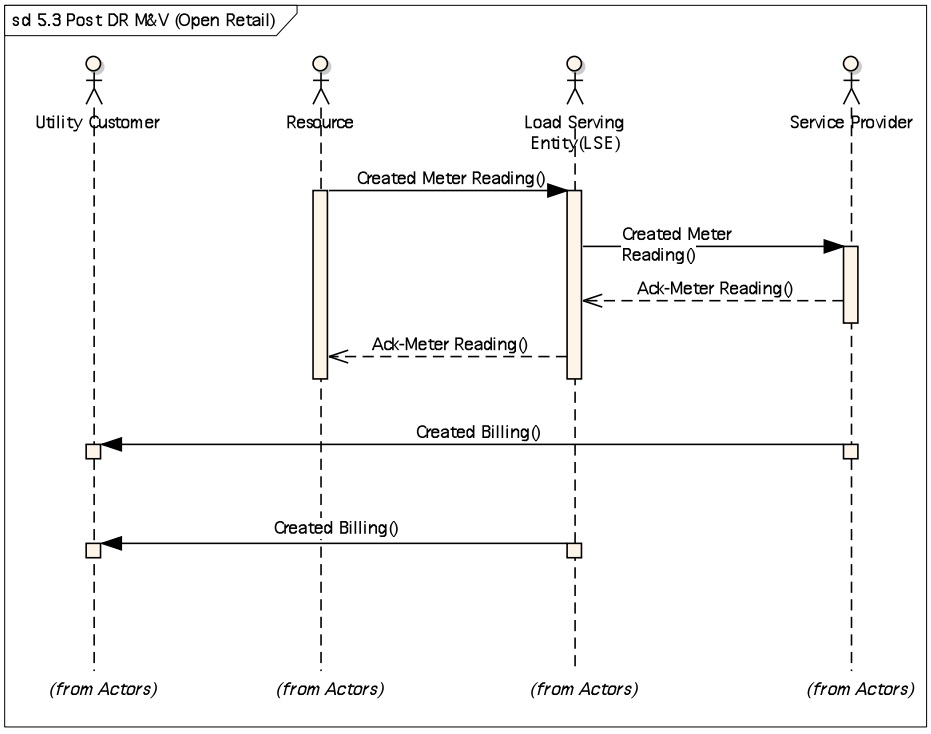
[5] In wholesale markets, the settlement for a DR Event is between the System Operator and Market Participant and possibly between the Market Participant and the Electricity Customer.

REQ.17.3.1.4.13.2 Post DR Event M&V / Settlement (Open Retail)

Description

After DR Event has been completed, Measurement and Verification (M&V) can confirm action has been taken or to measure the impact of the response. After the M&V, the Financial Settlement is calculated and sent to the Electricity Customer. This Use Case covers the scenarios with Open Retail Markets.

Sequence Diagram



REQ.17-A Appendix A – Entity-Relationship Model

The following terms and definitions correspond to a set of actor and objects within the overall information model for demand response. Figure 1A contains a data model used to illustrate the entity-relationships within the model. Abbreviations/Acronyms correspond to the IDs shown in the figure.

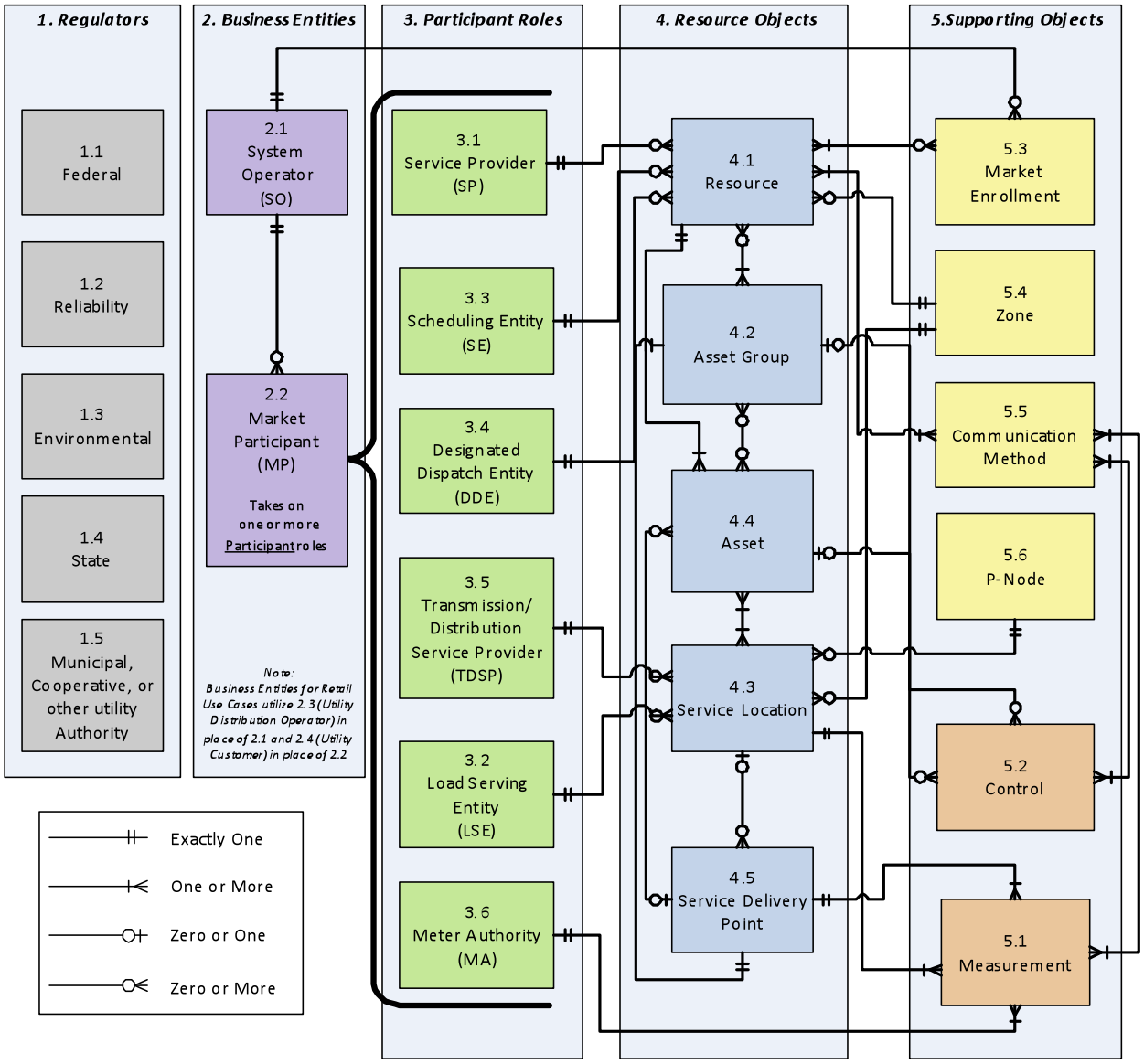
Proper (and Improper) Usage of the Entity-Relationship Model. The entity-relationship model is used to show cardinality among objects in the model, for example every Resource belongs to one and only one Service Provider and a Premise contains one or more End Devices. The entity-relationship model does not provide use case information; actors are objects in the model and do not "act" in the model. The entity-relationship model does not imply process. For example, a Service Provider is associated with many Resources; however the enrollment of those Resources may be managed by a System Operators or a Utility Distribution Operator. Both use cases and process maps are separate components of the Model Business Practices.

Reading Crow's Foot Notation. Objects in the model which share a relationship are connected with a cardinality line. Each end of the cardinality line contains a Crow's Foot notation, as documents in the legend of the figure. The four notations utilized are "exactly-one", "one-or-more", "zero-or-one", and "zero-or-more". The cardinality line is bi-directional; meaning it can be read in two directions. For example: a Premise is related to one-or-more End Devices (reading top to bottom) and every End Device is related to exactly-one Premise (reading bottom to top).

Optional Objects. The entity-relationship model is designed to support multiple business models and not every business model will require all objects to function. Therefore, all objects in the model are considered optional. For example, a Utility Distribution Operator may design a Demand Response program which requires the definition of Resources and Service Locations, but does not require Asset Groups and Assets.

Applicability to Retail and Wholesale. The entity-relationship model is applicable to both wholesale and retail. When using the model for wholesale, the applicable business entities are 2.1 (System Operator) and 2.3 (Market Participant), while in retail markets, the parallel business entities are 2.3 (Utility Distribution Operator) and 2.4 (Utility Customers). Other than the swapping of the two pairs of terms, the models are identical, including the names of and relationships among objects.

Figure 1A. Entity-Relationship Model for Smart Grid Use Cases



RECOMMENDATION TO NAESB EXECUTIVE COMMITTEE

For Quadrant:	**Retail Electric Quadrant**
Requesters:	**Smart Grid Interoperability Panel**
Request No.:	**2010 Retail Annual Plan Item 9(c)**
Request Title:	**Phase Two Requirements Specification for Retail Standard DR Signals – for NIST PAP09**

4. Supporting Documentation

a. Description of Request:

REQ Annual Plan Item 9(c) – "Develop Requirements and Use Cases for PAP 09 – Demand Response/Distributed Energy Resources"

b. Description of Recommendation:

This recommendation provides the data requirements related to the use cases developed as part of the phase one effort

c. Business Purpose:

This recommendation has been developed in response to a request from NIST to provide use cases and requirements germane to the development of standard DR and DER signals.

d. Commentary/Rationale of Subcommittee(s)/Task Force(s):

NAESB Smart Grid Standards Subcommittee Meeting Notes/Documents:

- March 11, 2010 Meeting Notes – To be posted
- March 18, 2010 Meeting Notes – To be posted
- March 25, 2010 Meeting Notes – To be posted
- April 1, 2010 Meeting Notes – To be posted
- April 8, 2010 Meeting Notes – To be posted
- April 29, 2010 Meeting Notes – To be posted
- May 13, 2010 Meeting Notes – To be posted
- May 20, 2010 Meeting Notes – To be posted
- June 10, 2010 Meeting Notes – To be posted
- June 17, 2010 Meeting Notes – http://www.naesb.org/pdf4/smart_grid_ssd061710notes.doc
- July 1, 2010 Meeting Notes – To be posted
- July 13-14, 2010 Meeting Notes – To be posted
- July 22, 2010 Meeting Notes – To be posted
- August 5, 2010 Meeting Notes – http://www.naesb.org/pdf4/smart_grid_ssd080510notes.doc
- August 12, 2010 Meeting Notes – http://www.naesb.org/pdf4/smart_grid_ssd081210notes.doc
- August 26, 2010 Meeting Notes – http://www.naesb.org/pdf4/smart_grid_ssd082610notes.doc

- September 9, 2010 Meeting Notes – http://www.naesb.org/pdf4/smart_grid_ssd090910notes.doc
- September 16, 2010 Meeting Notes – http://www.naesb.org/pdf4/smart_grid_ssd091610notes.doc
- September 23, 2010 Meeting Notes – To be posted